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Faraday - Genius of the dynamo

— By —

Terry Mitchell

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have this fluidity at normal temperature, it must be heated until proper fluidity is secured. In moderate climates, fuels of 25 deg. Baumé or over do not require heating, while fuels between 18 and 25 deg. need to be warmed slightly and fuels less than 18 deg. must be heated. A simple heating device consists of a jacketed fuel reservoir through which hot water is circulated. This water may come from the engine jackets but should be heated further in coils passing through the exhaust manifold where high temperature may be obtained without danger. Electric heating methods may be used also but these are more expensive to operate.

Heating of the fuel oil without cost or effort, after the installation has been made, is accomplished in a unique manner in a Madison, S. D. plant where the reënforced concrete tank shown in Fig. 1 was located under the cooling-tower basin. This particular tank is divided into several compartments so that both light and heavy oil may be stored. The light oil is used to start the engines, after which the supply is switched to the heavy oil. Division of the large tank also permits inspection and repair of any section but detection of a leak to the outside may be accomplished by having an accessible drain pit on one side into which lead channels underneath each section.

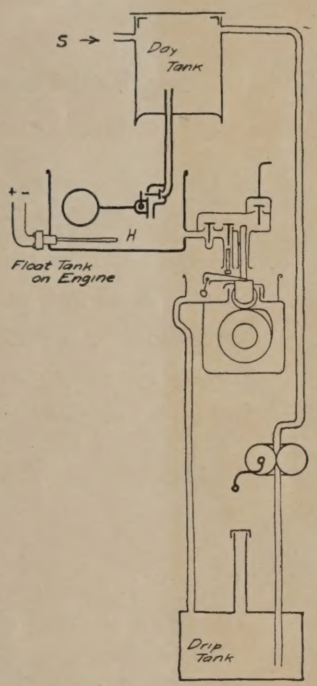

FIG. 5. ARRANGEMENT OF UNDER-FLOOR DRIP TANK AS AUXILIARY TO DAY TANK

Fuel Level Determination Methods

Use of day tanks makes fuel consumption record keeping simpler and more accurate. They also provide a means for settling out water and other impurities from the fuel and assist in controlling the rate of flow to the engine. When they are located above the floor line, they should be provided with gage glasses that may be seen readily from the engine-room floor as shown in Fig. 4. When they are below floor level, they should have float or pressure-operated gages. Even with day tanks so provided, the storage tank fuel level determinations should not be omitted. Determination of the fuel consumed from the readings of the storage-tank level indicator serves as a check on the total consumption found by adding the consumptions of the individual engine units as estimated from their day tank readings.

For storage tanks located out of doors, a simple housing should be provided for the indicator which may be operated by a sounding pipe in which there is a float. Some engines draw directly from storage tanks without the intervention of a day tank. In such installations, a float or pressure operated indicator furnishes a fairly reliable means for measuring the fuel consumed and in such cases each engine should have its individual tank, for in no other way can the amount of fuel used by each engine be determined.

Tanks installed below floor level sometimes are provided with floats to permit using an overhead-gravity tank which is situated higher than the engine. This under-floor drip tank is vented to some point outside of the engine room so that the pressure in it is atmospheric, as shown in Fig. 5.

Ventilating pipes should terminate with a goose neck or be provided with a cap as shown in Fig. 5 to prevent admission of dirt and water and a fine gauze screen should be fitted across the open end of ventilating pipes of all tanks to prevent flames resulting from accidental ignition of issuing vapors from entering the tank through the pipe. The engine tank shown in Fig. 5 is provided with an electric bayonet heater H, which maintains the proper oil temperature automatically. The day tank may be supplied with fuel at S either by gravity from a supply tank or direct by the transfer pump. Oil is drawn from it by the auxiliary fuel pump and returns enter it from the overflow and from leakage from the pump and spray valves. Float-equipped tanks may be made considerably smaller than under-floor tanks which are used as reservoirs.

To avoid interruption in service because of fuel tanks running dry, each engine may be provided with a simple electrical alarm device.

Ventilate Tank Before Entering It

Sludge and sediment which gather inevitably at the bottom of fuel tanks are not always removed easily by flushing with warm water and usually require some manual application for thorough removal. Before entering a storage tank for any purpose, care should be taken to ventilate it thoroughly to remove suffocating gas. Even then, no open flame should be allowed in the tank or near the opening; no light, save an electric bulb with a wire guard, should ever be used. If the bulb is unguarded, it may break; the heat of the filament has ignited gases in a number of cases.

If natural airing is resorted to, at least 12 hr. should be taken for the airing process. Where it is necessary to enter the tank before this, ventilation may be accomplished by use of compressed air. If air is forced into the tank at about 45 lb. press. through a ½-in. line connected to the drain valve, the tank may be entered without danger after an hour's blow but the air injection should be continued while anyone is working in the tank, although its pressure may be reduced somewhat. This method requires a large amount of air but it saves considerable time.

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Faraday—Genius

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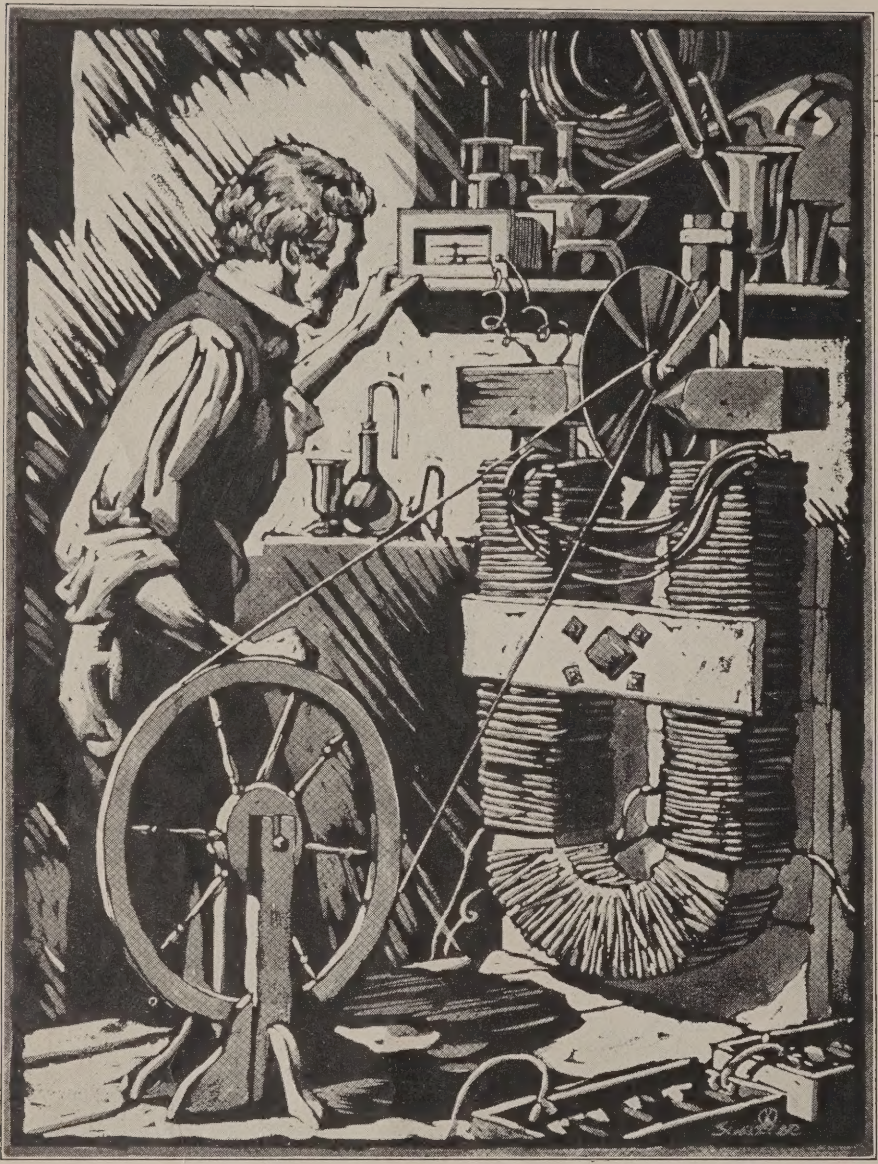

Photo Courtesy Machine Design

Michael Faraday and the Dynamo

A Great moment in the history of electrical engineering. On November 4, 1831, by spinning a copper disc between the poles of the Great horseshoe magnet of the Royal Society Faraday created the world's first direct current generator.

IN THE NEXT few months, a great deal will be heard about Michael Faraday, for 1931 marks the hundredth anniversary of his incomparable discovery of electromagnetic induction. A brilliant celebration in honor of Faraday is to be held the third week in September at London, where he carried out his experiments, and many of the foremost scientists of our day will attend the sessions. It happens that the centenary of James Clerk Maxwell falls at the same time: Maxwell interpreted into mathematical form the principles brought to light by Faraday. The celebration will thus have a double significance.

The story of Faraday's life and achievements is full of interest to engineers and laymen alike, whether told in brief outline, as here, or in several volumes.

Born the son of an obscure blacksmith, and given only a meager education, he became, in the words of Tyndall, "the greatest experimental philosopher the world has even seen".

Like the American scientist, Franklin, Faraday in his early youth served as apprentice in a bookshop. He later explained how an article on electricity in a copy of the Encyclopaedia Britannica, which he was binding, first interested him in science. He then made what experiments he could in both chemistry and electricity; his original machine for producing static electricity has by good fortune been preserved, as have the sketches, in Franklin's own hand, of his design for similar apparatus.

Seeing by chance a sign announcing some lectures to be given on scientific subjects, Faraday borrowed the small sums necessary for admission and made careful notes of all that he heard. These notes were later brought to the attention of a famous chemist, Sir Humphrey Davy, and were the means of Faraday's acceptance as an assistant to Davy in the laboratories of the Royal Institution. When Davy went to the Continent to visit the wonders of scientific interest in various countries and to confer with other celebrated chemists, he took Faraday with him. After eighteen months of

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Of The Dynam

Anniversary of Michael Faraday's covery of Electromagnetic Induction

By Terry Mitchell

this, they returned to London and Faraday launched upon the 40 years of his magnificent service to research. The first period of his work was concerned chiefly with chemical investigations and studies of the technical methods which were to be the basis of his ultimate achievements.

Faraday's discovery of electromagnetic induction was by no means a matter of chance. For two hundred years before his time, scientists had known that lines of force of some kind surround a magnet, their effect being shown by the arrangement of iron filings into curved lines when vibrated on a plate above the magnet. Later it was found that an iron core, surrounded by a coil of copper wire, would become strongly magnetized when an electric current from a battery was run through the wire. As early as 1822, Faraday had begun to suspect that the converse should be true and had written in his notebook, ''Convert magnetism into electricity.''

But this, which has proved to be the foundation of nearly all of the electrical wonders we know and use, had never been done, and nearly ten long years went by before Faraday himself could accomplish the feat. He repeatedly tried to gain his object by placing an iron magnet in a helix of wire, the ends of which were then connected to a simple form of galvanometer, no current was observed to flow. Although baffled by the obstinate failure of the experiment, Faraday never lost faith in his idea that electricity and magnetism must be related. He kept turning his mind back to the problem. For many months he carried in his waistcoat pocket a straight piece of iron, about an inch in length, with a few turns of wire wrapped around it; this model he would take out and study at odd times in the effort to unravel the secret with the aid of sight and touch.

Other investigators were likewise pondering the same question; in 1824 it was discovered that a copper disk, rotating beneath a compass needle, caused it to swing in the same direction. This effect was duplicated in other tests, with apparatus arranged in various ways, and it seems to us now that such men as Ampere, Arago, Herschel and Sturgeon could hardly have failed to sense the meaning of what they observed. Faraday knew of their theories and again in 1828 tried vainly to make his magnet-and-coil combination produce a current. He had not yet learned that it was the relative *motion* of the two that was all important.

The statue of Faraday standing in the entrance hall of the Royal Institution shows him holding in his hand an iron ring with wires wound around it. The original ring, preserved in the museum of the Institution, is the one Faraday used in finding the present of the induced current for the first time (August 30, 1831). The ring he magnetized by running a current from a wet battery through a wire coiled on one side of it; a second insu-

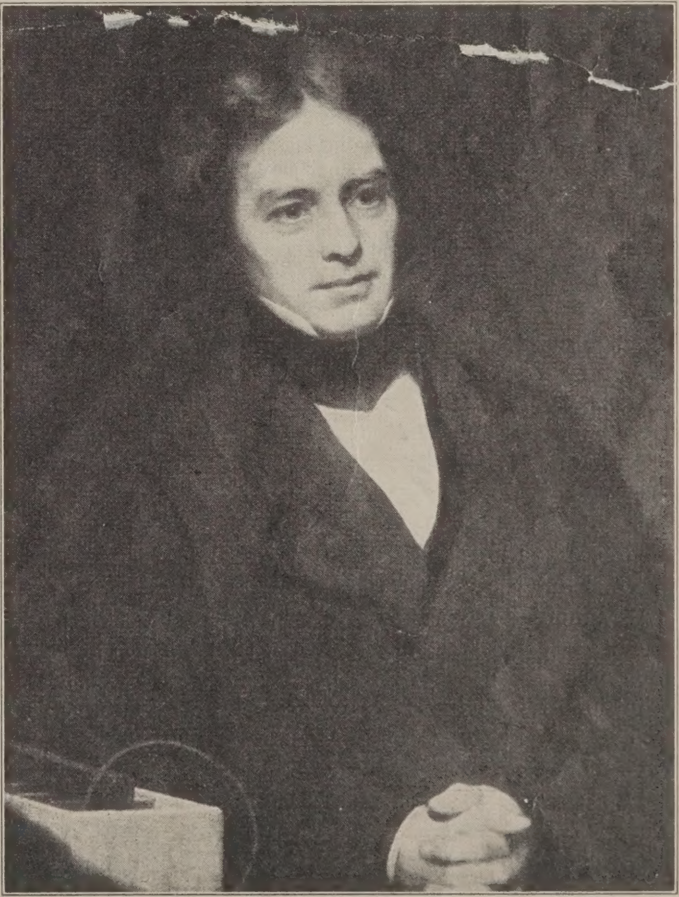

Photo Courtesy General Electric Co.

FIG. 1. MICHAEL FARADAY, DISCOVERER OF ELECTROMAGNETIC INDUCTION

lated wire, wrapped on the other side, had its free ends joined over a magnetic needle placed three feet away. When the connection to the battery was *made* or *broken*, the needle oscillated—and Faraday saw the light.

In ten days devoted to the work, between that day and the fourth of November, he achieved what he had dreamed of doing for as many years, rapidly feeling his way from the ring to a bar of iron inside a coil, the bar being temporarily magnetized by touching it with other magnets; thence to the delicate effect of the current in a coil upon a second coil wound around it; from this to creating a current in a helix by thrusting a bar magnet into it; and then, by spinning a copper disc between the poles of the great horsehoe magnet of the Royal Society, the axis and edge of the disc being wired to a galvanometer, he created the *world's first direct-current generator;* finally, he moved a wire across the field of the magnet and found the desired effect, which he stated was caused by the *cutting* of the lines of force—the gist of the whole story, and the same lines had been seen for those two hundred years!

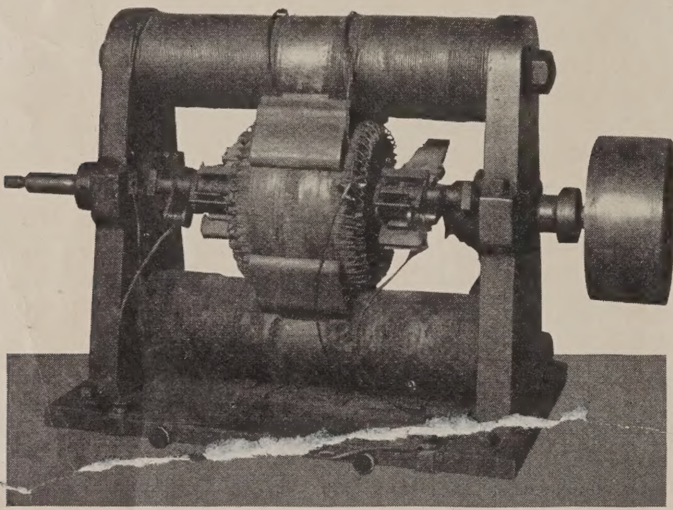

FIG. 2. THE JOINT DYNAMO MADE IN AMERICA CONSTRUCTED AT CORNELL UNIVERSITY IN 1875 BY WM. A. ANTHONY AND GEORGE S. MOLER

Shortly afterward, he produced sparks of electricity with currents from his magnet and wire, showed how the current would make fine wires turn red hot and that it would cause chemical changes in solutions. He developed several kinds of electrical machines or dynamos, his masterful experiments opening up a new world for investigators everywhere. In subsequent years, he evolved the principles of electro-magnetic and electro-chemical action; he discovered diamagnetism, and worked out the effects of magnetism on polarized light. Throughout a life of great labor, his genius shone upon everything he touched and his thousands of experiments, recorded accurately in his daily notes, show with what marvelous insight he handled technical problems of every kind. A study of his work and methods will repay anyone of scientific mind.

So earnest in the search for new knowledge was Faraday that he had time for nothing outside of his researches and lectures. He lived on an income averaging a few hundred dollars a year, refusing consultation work that would have paid him $25,000 or even more, in the same period. He never applied for patents on the things he discovered at such sacrifice, but promptly published his findings, to serve as a basis for useful inventions by others. Meanwhile his energies were turned toward new fields.

All his life he adhered to the strict religious teaching of an obscure sect called the Sandemanians, to which church his wife also belonged. Their beliefs corresponded closely to those of the Mennonites in Pennsylvania. When an invitation from Queen Victoria caused Faraday, who had been elected an elder, to miss the service one Sunday, he was put out of the church by the straight laced members. He continued to attend, however, and after ten years or more of excommunication was readmitted.

Honors by the score were rained upon him, from all over the Continent as well as England, but he declined to tax his strength with social engagements, and gave his extra income to charity. His manner was patient and kindly, reflecting the true greatness of his soul. He was, withal, very human, and it is said that he mixed a splendid bowl and wielded a good fork over a leg of mutton.

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CHARLES E. SKINNER, assistant director of engineering, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., was elected president of the American Institute of Electrical Engineers for the year beginning August 1, 1931, as announced at the annual meeting of the Institute held at Asheville, N. C., June 22, during the annual summer convention of the Institute. The other officers elected were: Vice-Presidents W. B. Kouwenhoven, Baltimore, Md.; W. E. Freeman, Lexington, Ky.; Paul H. Patton, Omaha, Neb.; A. W. Copley, San Francisco, Calif.; L. B. Chubbuck, Hamilton, Ont.—Directors L. W. Chubb, East Pittsburgh, Pa.; B. D. Hull, Dallas, Tex.; H. R. Woodrow, Brooklyn, N. Y.—National Treasurer W. I. Slichter, New York, N. Y. (reëlected).

These officers, together with the following hold-over officers, will constitute the Board of Directors for the next administrative year, beginning August 1: W. S. Lee (retiring president), Charlotte, N. C.; Harold B. Smith, Princeton, Mass.; H. V. Carpenter, Pullman, Wash.; G. C. Shaad, Lawrence, Kans.; I. E. Moultrop, Boston, Mass.; H. P. Charlesworth, New York, N. Y.; T. N. Lacy, Detroit, Mich.; J. Allen Johnson, Buffalo, N. Y.; A. M. MacCutcheon, Cleveland, Ohio; A. E. Bettis, Kansas City, Mo.; J. E. Kearns, Chicago, Ill.; F. W. Peek, Jr., Pittsfield, Mass.; C. E. Stephens, New York, N. Y.; A. B. Cooper, Toronto, Ont.; A. E. Knowlton and R. H. Tapscott, New York, N. Y.

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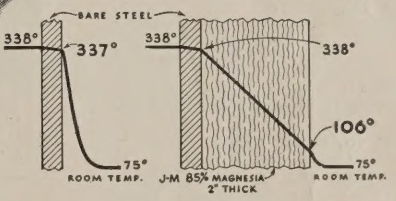

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- Permutit Co., New York.
- Scaife & Sons Co., Wm. B., Oakmont, Pa.

FILTERS, Air
- American Air Filter Co., Louisville.

FILTERS, Oil
- Burt Mfg. Co., The, Akron, O.

FILTERS, Water
- Cochrane Corp., Philadelphia.
- Filtrators Co., Inc., New York.
- International Filter Co., Chicago.
- Permutit Co., New York.
- Scaife & Sons Co., Wm. B., Oakmont, Pa.

FIRE BRICK
- Carborundum Co., Perth Amboy.
- General Insulating & Mfg. Co., Alexandria, Ind.

FIRE BRICK CEMENT
- General Insulating & Mfg. Co., Alexandria, Ind.

FIRE CLAY
- Carborundum Co., Perth Amboy.

FIRE HYDRANTS
- Howard Iron Works, Buffalo.
- Kennedy Valve Mfg. Co., The, Elmira, N. Y.

FITTINGS, Flange and Pipe
- Fisher Governor Co., Inc., Marshalltown, Ia.
- Kennedy Valve Mfg. Co., The, Elmira, N. Y.
- Limbert & Co., Geo. B., Chicago.

FLANGES
- Dart Mfg. Co., E. M., Providence, R. I.
- Limbert & Co., Geo. B., Chicago.

FLOATS
- Reliance Gauge Column Co., Cleveland.

FLOW METERS
- Bailey Meter Co., Cleveland, O.
- Brown Inst. Co., Phila., Pa.
- Republic Flow Meters Co., Chicago, Ill.

FLUE CLEANERS
- Bayer Co., The, St. Louis, Mo.
- Diamond Power Spec. Corp., Detroit, Mich.
- General Specialty Co., Buffalo.
- Lagonda Mfg. Co., Springfield, Ohio.
- Liberty Mfg. Co., Jeannette, Pa.
- Pierce Co., Wm. B., Buffalo.

FLUE GAS ANALYSIS INSTRUMENTS
- Hays Corp., Michigan City, Ind.
- Permutit Co., New York.

FURNACE FIRE OBSERVERS
- Springfield Boiler Co., Springfield, Ill.

FURNACE SURFACES, Water Cooled
- Foster Wheeler Corp., New York.
- Fuller Lehigh Co., New York.

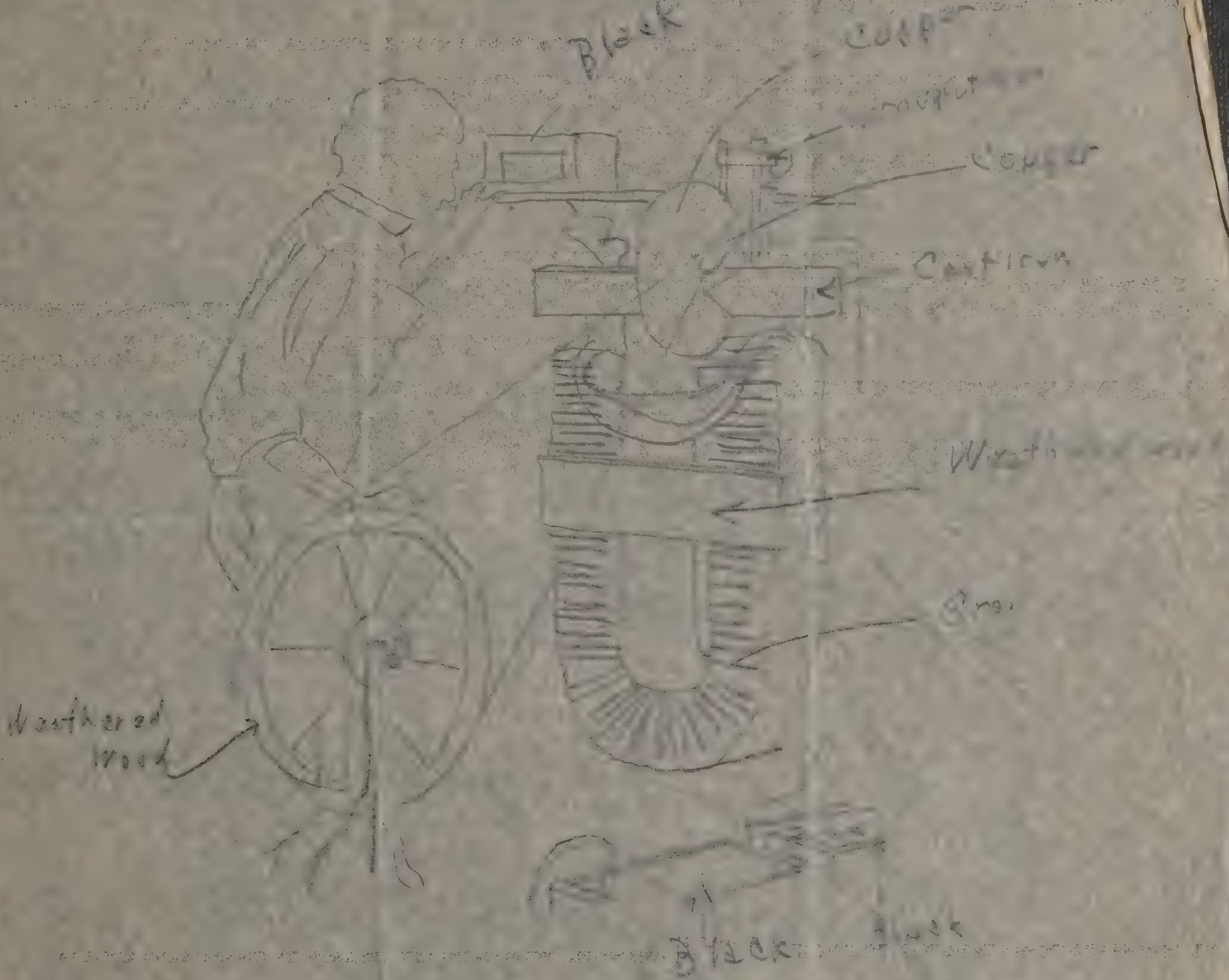
FURNACE WALLS
- Combustion Engrg. Corp., N. Y.

FURNACES, Water Cooled, Refractory
- Erie City Iron Works, Erie, Pa.

GAS BURNERS
- Peabody Engrg. Corp., N. Y.

GAS COLLECTORS
- Hays Corp., Michigan City, Ind.

GAS PRODUCERS
- Wellman Engrg. Co., Cleveland.



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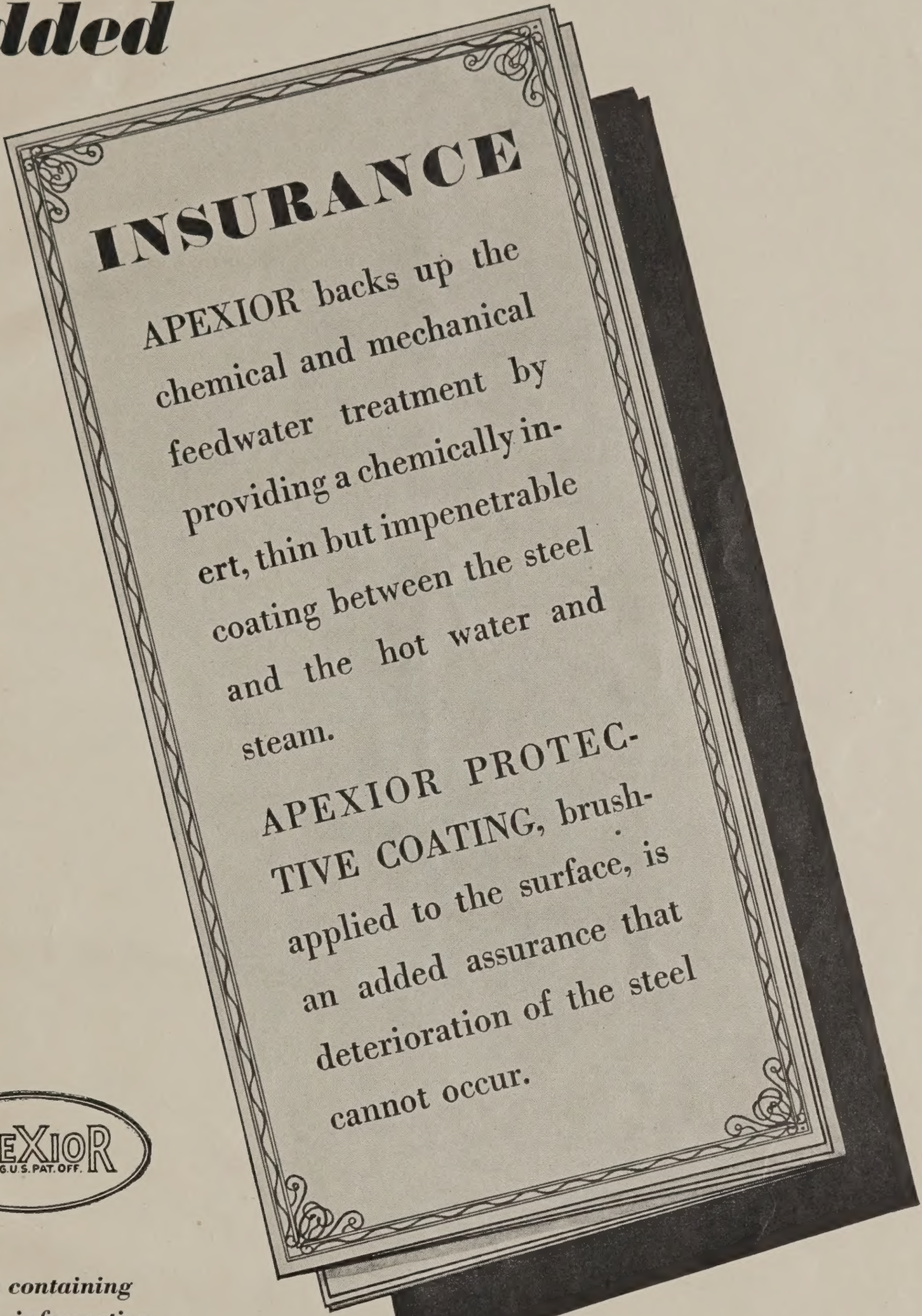
APEXIOR *will give boilers an added*



INSURANCE

APEXIOR backs up the chemical and mechanical feedwater treatment by providing a chemically inert, thin but impenetrable coating between the steel and the hot water and steam.

APEXIOR PROTECTIVE COATING, brush-applied to the surface, is an added assurance that deterioration of the steel cannot occur.

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GASKETS
- Crandall Pkg. Co., Palmyra, N. Y.
- Darcoid Co., Inc., New York.
- Garlock Pkg. Co., Palmyra.
- Johns-Manville Corp., New York.
- Metallo Gasket Co., New Brunswick, N. J.
- Smooth-On Mfg. Co., Jersey City.

GAUGE COCKS
- H. Belfield Co., Philadelphia, Pa.
- Lonergan Co., J. E., Phila., Pa.
- Reliance Gauge Column Co., Cleveland.

GAUGE GLASSES
- Jenkins Bros., New York, N. Y.

GAUGE TESTERS
- Fisher Governor Co., Inc., Marshalltown, Ia.

GAUGES, Differential and U-Tube
- Hays Corp., Michigan City, Ind.

GAUGES, Draft and Liquid Level
- Bailey Meter Co., Cleveland, O.
- Bristol Co., The, Waterbury.
- Brown Inst. Co., Phila., Pa.
- Hays Corp., Michigan City, Ind.
- Pierce Co., Wm. B., Buffalo.
- Republic Flow Meters Co., Chicago.

GAUGES, Pressure and Recording
- Bristol Co., The, Waterbury.
- Lonergan Co., J. E., Phila., Pa.

GAUGES, Water
- Lonergan Co., J. E., Phila., Pa.
- Reliance Gauge Column Co., Cleveland.

GEARS. Reduction and Double Helical
- De Laval Steam Turbine Co., Trenton, N. J.
- Moore Steam Turbine Corp., Wellsville, N. Y.
- Terry Steam Turbine Co., The, Hartford, Conn.

GENERATING SETS
- Allis-Chalmers Mfg. Co., Milwaukee, Wis.
- Fairbanks, Morse & Co., Chicago.
- Moore Steam Turbine Corp., Wellsville, N. Y.
- Terry Steam Turbine Co., Hartford, Conn.

GENERATORS, Electric
- Allis-Chalmers Mfg. Co., Milwaukee, Wis.
- Elliott Co., Jeannette, Pa.

GOVERNORS, Compressor Unloader
- Pickering Governor Co., Portland, Conn.

GOVERNORS, Engine
- Pickering Governor Co., Portland, Conn.

GOVERNORS, Pump
- Atlas Valve Co., Newark, N. J.
- Chaplin-Fulton Mfg. Co., The, Pittsburgh.
- Fisher Governor Co., Inc., Marshalltown, Ia.
- Northern Equipment Co., Erie.
- Squires Co., C. E., Cleveland.
- Wright-Austin Co.

GRAPHITE
- Dixon Crucible Co., Jos., Jersey City, N. J.

GRATE BARS
- Flynn & Emrich Co., Baltimore.

GRATES
- Flynn & Emrich Co., Baltimore.
- Kelly Foundry & Mach. Co., Goshen, Ind.
- Neemes Fdry., Inc., Troy, N. Y.

GREASE
- Dearborn Chemical Co., Chicago.
- Dixon Crucible Co., Jos., Jersey City, N. J.
- Keystone Lubricating Co., Phila.
- Standard Oil Co. (Indiana), Chicago, Ill.
- Texas Co., The, New York.
- Vacuum Oil Co., New York.

GREASE CUPS
- (See Oil and Grease Cups.)

GUNS, Refractory and Cement
- Cement Gun Co., Allentown, Pa.

HEAT EXCHANGERS
- Elgin Softener Corp., Elgin, Ill.
- Foster Wheeler Corp., New York.
- Griscom-Russell Co., New York.
- National Pipe Bending Co., New Haven, Conn.
- Wheeler Mfg. Co., C. H., Phila.

HEATERS, Air
- Prat-Daniel Corp., New York

HEATERS, Bleeder
- Foster Wheeler Corp., New York.
- Griscom-Russell Co., New York.

HEATERS FOR SPECIAL PURPOSES AND STORAGE
- National Pipe Bending Co., New Haven, Conn.

HEATERS, Hot Water
- Foster Wheeler Corp., New York.
- Griscom-Russell Co., New York.
- National Pipe Bending Co., New Haven, Conn.

HEATERS, Oil
- Hammel Oil Burning Equipment Co., Inc., Providence, R. I.
- National Pipe Bending Co., New Haven, Conn.
- Wheeler Mfg. Co., C. H., Phila.

HOISTS, Skip
- Brady Conveyors Corp., Chicago.

HOPPERS AND BINS, Coal and Ash
- Brady Conveyors Corp., Chicago.
- Connery & Co., Inc., Phila.

HOSE
- Pioneer Rubber Mills, San Francisco.

INSTRUMENTS, Electrical
- Leeds & Northrup Co., Phila.

INSULATING MATERIAL
- Carey Co., Philip, Cincinnati.
- General Insulating & Mfg. Co., Alexandria, Ind.
- Johns-Manville Corp., New York.

JOINTS, Expansion
- Foster Wheeler Corp., New York.
- Howard Iron Works, Buffalo.
- Sharon Co., R. W., Pittsburgh.
- Wheeler Mfg. Co., C. H., Phila.
- Yarnall Waring Co., Phila.

LININGS, Coal Bunker
- Wailes Dove-Hermiston Corp., N. Y.

LININGS, Furnace
- Norton Co., Worcester.

LOADERS AND UNLOADERS
- Brady Conveyors Corp., Chicago.

LUBRICANTS
- Dearborn Chemical Co., Chicago.
- Dixon Crucible Co., Jos., Jersey City, N. J.
- Keystone Lubricating Co., Phila.
- Standard Oil Co. (Indiana), Chicago, Ill.
- Texas Co., The, New York.
- Vacuum Oil Co., New York.

LUBRICATORS
- Keystone Lubricating Co., Phila.
- Williams Valve Co., D. T., Cincinnati.

METERS, Air and Gas
- Bailey Meter Co, Cleveland, O.
- Republic Flow Meters Co., Chicago.

METERS, Boiler
- Bailey Meter Co., Cleveland, O.
- Brown Inst. Co., Phila., Pa.
- Republic Flow Meters Co., Chicago.

METERS, Coal
- Bailey Meter Co., Cleveland, O.
- Republic Flow Meters Co., Chicago.

METERS, Feedwater and Steam
- Bailey Meter Co., Cleveland, O.
- Brown Inst. Co., Phila., Pa.
- Cochrane Corp., Philadelphia.
- Hoppes Mfg. Co., Springfield, O.
- Republic Flow Meters Co., Chicago.
- Simplex Valve & Meter Co., Philadelphia.
- Worthington Pump & Mach. Corp., New York.

METERS V NOTCH
- Yarnall-Waring Co., Phila.

METERS, Water
- Bailey Meter Co., Cleveland, O.
- Cochrane Corp., Philadelphia.
- Hoppes Mfg. Co., Springfield, O.
- International Filter Co., Chicago.
- Republic Flow Meters Co., Chicago.
- Simplex Valve & Meter Co., Philadelphia.

MOTORS
- Allis - Chalmers Mfg. Co., Milwaukee, Wis.
- Fairbanks, Morse & Co., Chicago.

NOZZLES FOR ALL PURPOSES
- Marley Co., Kansas City, Mo.
- Yarnall-Waring Co., Phila.

OIL AND GREASE CUPS
- Keystone Lubricating Co., Phila.
- Lonergan Co., J. E., Phila., Pa.
- Williams Valve Co., D. T., Cincinnati.

OIL, Coal and Gas Burning Equipment
- Combustion Engrg. Corp., N. Y.
- Engineer Co., New York, N. Y.
- Hammel Oil Burning Equipment Co., Inc., Providence, R. I.
- Peabody Engrg. Corp., N. Y.

OIL PURIFIERS
- De Laval Separator Co., N. Y.
- De Laval Steam Turbine Co., Trenton, N. J.

OIL SEPARATORS
- De Laval Separator Co., N. Y.
- Elliott Co., Jeannette, Pa.
- Wright-Austin Co., Detroit, Mich.

OIL TESTING APPARATUS
- Burgess-Parr Co., Chicago, Ill.

OILING SYSTEMS
- Burt Mfg. Co., The, Akron, O.
- De Laval Separator Co., N. Y.

OILS, Lubricating
- Dearborn Chemical Co., Chicago.
- Standard Oil Co. (Indiana), Chicago, Ill.
- Texas Co., The, New York.
- Vacuum Oil Co., New York.

PACKING ASBESTOS, Flax and Metallic
- Crandall Pkg. Co., Palmyra, N. Y.
- Crane Packing Co., Chicago.
- Garlock Pkg. Co., Palmyra.

PACKING, Centrifugal Pump
- Crandall Pkg. Co., Palmyra, N. Y.
- Garlock Pkg. Co., Palmyra.

PACKING, Metallic for Condenser Tubes
- Crane Packing Co., Chicago.

PACKING, Piston and Rod, Valve Stem
- Crandall Pkg. Co., Palmyra, N. Y.
- Crane Packing Co., Chicago.
- Darcoid Co., Inc., New York.
- Garlock Pkg. Co., Palmyra.
- Johns-Manville Corp., New York.
- Pioneer Rubber Mills, San Francisco.

PACKING, Sheet
- Crandall Pkg. Co., Palmyra, N. Y.
- Darcoid Co., Inc., New York.
- Garlock Pkg. Co., Palmyra.
- Jenkins Bros., New York, N. Y.
- Johns-Manville Corp., New York.
- Pioneer Rubber Mills, San Francisco.

PAINT, Acid, Alkali and Water Resistant
- Wailes Dove-Hermiston Corp., New York. N. Y.

PAINT, Anti-Corrosive, Metal and Protective
- Dampney Co. of America, Boston, Mass.
- Wailes Dove-Hermiston Corp., New York, N. Y.

PAINT, Floor
- Wailes Dove-Hermiston Corp., New York, N. Y.

PAINT, Graphite
- Dixon Crucible Co., Jos., Jersey City, N. J.

PAINT, Heat Resisting
- Dampney Co. of America, Boston, Mass.
- Wailes Dove-Hermiston Corp., New York, N. Y.

PAINT, Steel Preservative
- Dampney Co. of America, Boston, Mass.
- Wailes Dove-Hermiston Corp., New York, N. Y.

PIPE BENDING
- Limbert & Co., Geo. B., Chicago.
- Midwest Piping & Supply Co., St. Louis, Mo.
- National Pipe Bending Co., New Haven, Conn.
- Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.

PIPE COILS
- Limbert & Co., Geo. B., Chicago.
- Midwest Piping & Supply Co., St. Louis, Mo.
- National Pipe Bending Co., New Haven, Conn.
- Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.

PIPE COVERINGS
- Carey Co., Philip, Cincinnati.
- General Insulating & Mfg. Co., Alexandria, Ind.
- Johns-Manville Corp., New York.

PIPE CUTTERS
- Toledo Pipe Threading Mach. Co., The, Toledo, O.

PIPE HANGERS & SUPPLIES
- Limbert & Co., Geo. B., Chicago.

PIPE THREADING MACHINES
- Toledo Pipe Threading Mach. Co., The, Toledo, O.

PIPING
- Connery & Co., Inc., Phila.
- Limbert & Co., Geo. B., Chicago.
- Midwest Piping & Supply Co., St. Louis, Mo.
- National Tube Co., Pittsburgh.
- Pittsburgh Piping & Equipment Co., Pittsburgh.
- Republic Steel Corp., Youngstown.

PIPING CONTRACTING MANUFACTURERS AND FABRICATORS
- Limbert & Co., Geo. B., Chicago.
- Midwest Piping & Supply Co., St. Louis, Mo.
- Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.

PROTECTIVE COATINGS
- Dampney Co. of America, Boston, Mass.
- Wailes Dove-Hermiston Corp., New York, N. Y.

PULVERIZED COAL BURNERS
- Erie City Iron Works, Erie, Pa.
- Fuller Lehigh Co., New York.
- Peabody Engrg. Corp., N. Y.

PULVERIZED COAL FEEDERS
- Fuller Lehigh Co., New York.

PULVERIZED FUEL EQUIPMENT
- Combustion Engrg. Corp., N. Y.
- Erie City Iron Works, Erie, Pa.
- Foster Wheeler Corp., N. Y.
- Fuller Lehigh Co., New York.
- Kennedy-Van Saun Mfg. & Eng. Corp., New York, N. Y.

PULVERIZERS, Coal and Limestone.
- American Pulverizer Co., St. Louis.
- Fuller Lehigh Co., New York.
- Kennedy-Van Saun Mfg. & Eng. Corp., New York, N. Y.
- Pennsylvania Crusher Co., Phila.
- Strong-Scott Mfg. Co., Minneapolis, Minn.

PUMPS, Air Lift
- Pennsylvania Pump & Compressor Co., Easton, Pa.

PUMPS, Boiler Feed
- Allis-Chalmers Mfg. Co., Milwaukee, Wis.
- American Steam Pump Co., Battle Creek, Mich.
- De Laval Steam Turbine Co., Trenton, N. J.
- Fairbanks, Morse & Co., Chicago.
- Foster Wheeler Corp., New York.
- Frederick Iron & Steel Co., Frederick, Md.
- Kingsford Fdry. & Mach. Wks., Oswego, N. Y.
- Lecourtenay Co., Newark, N. J.
- Manistee Iron Works Co., Manistee, Mich.
- Moore Steam Turbine Corp., Wellsville, N. Y.
- Terry Steam Turbine Co., The, Hartford, Conn.
- Warren Steam Pump Co., Inc., Warren, Mass.
- Worthington Pump & Machy. Corp., New York.

PUMPS, Centrifugal
- Allis - Chalmers Mfg. Co., Milwaukee, Wis.
- American Steam Pump Co., Battle Creek, Mich.
- De Laval Steam Turbine Co., Trenton, N. J.
- Fairbanks, Morse & Co., Chicago.
- Foster Wheeler Corp., New York.
- Frederick Iron & Steel Co., Frederick, Md.
- Kingsford Fdry. & Mach. Wks., Oswego, N. Y.
- Lecourtenay Co., Newark, N. J.
- Manistee Iron Works Co., Manistee, Mich.
- Moore Steam Turbine Corp., Wellsville, N. Y.
- Nash Engrg. Co., S. Norwalk.
- Pennsylvania Pump & Compressor Co., Easton, Pa.
- Terry Steam Turbine Co., Hartford, Conn.
- Warren Steam Pump Co., Inc., Warren, Mass.
- Wheeler Mfg. Co., C. H., Phila.
- Worthington Pump & Mach. Corp., New York.

PUMPS, Deep Well
- American Steam Pump Co., Battle Creek, Mich.
- Fairbanks, Morse & Co., Chicago.
- Worthington Pump & Mach. Corp., New York.

PUMPS, Elevator and Fire, General Service
- American Steam Pump Co., Battle Creek, Mich.
- De Laval Steam Turbine Co., Trenton, N. J.
- Frederick Iron & Steel Co., Frederick, Md.
- Lecourtenay Co., Newark, N. J.
- Manistee Iron Works Co., Manistee, Mich.
- Nash Engrg. Co., S. Norwalk.
- Warren Steam Pump Co., Inc., Warren, Mass.

PUMPS, Hydraulic Pressure
- American Steam Pump Co., Battle Creek, Mich.
- Frederick Iron & Steel Co., Frederick, Md.
- Manistee Iron Works Co., Manistee, Mich.
- Warren Steam Pump Co., Inc., Warren, Mass.

PUMPS, Oil
- Frederick Iron & Steel Co., Frederick, Md.
- Hammel Oil Burning Equipment Co., Inc., Providence, R. I.
- Lonergan Co., J. E., Phila., Pa.
- Warren Steam Pump Co., Inc., Warren, Mass.

PUMPS, Power and Electric
- American Steam Pump Co., Battle Creek, Mich.
- Fairbanks, Morse & Co., Chicago.
- Frederick Iron & Steel Co., Frederick, Md.
- Lecourtenay Co., Newark, N. J.
- Warren Steam Pump Co., Inc., Warren, Mass.
- Worthington Pump & Mach. Corp., New York.

PUMPS, Pulverized Coal
- Fuller Lehigh Co., New York.

PUMPS, Rotary
- Manistee Iron Works Co., Manistee, Mich.
- Wheeler Mfg. Co., C. H., Phila.

PUMPS, Turbine
- Moore Steam Turbine Corp., Wellsville, N. Y.

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